# Novel Ultralow-Weight Metal Rubber Sensor System for Ultra Long-Duration Scientific Balloons, Phase I

Completed Technology Project (2009 - 2009)

## Project Introduction

NanoSonic proposes to develop an innovative, ultralow mass density, and non-intrusive sensor system for ultra long duration balloons that will operate in the most extreme environmental conditions. Specifically, the sensors would be integrated onto the load bearing seams and/or outer balloon mesh surface of the pressurized balloon system to accurately and continually measure axial loads. Large axial load forces and wide/extreme temperature ranges (-90

o

C to >450

o

C) are typical for planetary balloon missions, therefore a durable, flexible, and thermally stable sensor material. NanoSonic would use its highly flexible, low-modulus Metal Rubber

TM

(MR

TM

) materials as strain/pressure sensors that are capable of large cyclic deformation without failure. MR

TM

is a free-standing nanocomposite material produced by the layer-by-layer combination of high performance polymers and electrically-conducting metal nanoparticles that provide durability and recoverability for sensor transduction, and a wide thermal operation range. Importantly, MR

TM

can behave like a rubber band in that it can be folded and compressed for stowage and then can be deployed and continually pressurized and stretched without failure during operation. Also, because of the very low amount of metallic nanoclusters in the system (<0.02 volume %), the sensor system is extremely low-weight and would not alter the performance of the balloon.

## Anticipated Benefits

Potential NASA Commercial Applications: There is a large market for low-weight high strain sensors for scientific balloons and similar inflatable systems, specifically for NASA and the aircraft industry. NanoSonic's low modulus Metal Rubber

TM

sensor plies and multi-element sensor arrays have unique applications in systems where strain is large and conventional stress and strain sensors mechanically fail. Such applications include flexible sensing garments for


Novel Ultralow-Weight Metal Rubber Sensor System for Ultra Long-Duration Scientific Balloons, Phase I

## Table of Contents

| | |
|---|---|
| Project Introduction | 1 |
| Anticipated Benefits | 1 |
| Primary U.S. Work Locations and Key Partners | 2 |
| Organizational Responsibility | 2 |
| Project Management | 2 |
| Technology Maturity (TRL) | 2 |
| Project Transitions | 3 |
| Technology Areas | 3 |

# Novel Ultralow-Weight Metal Rubber Sensor System for Ultra Long-Duration Scientific Balloons, Phase I

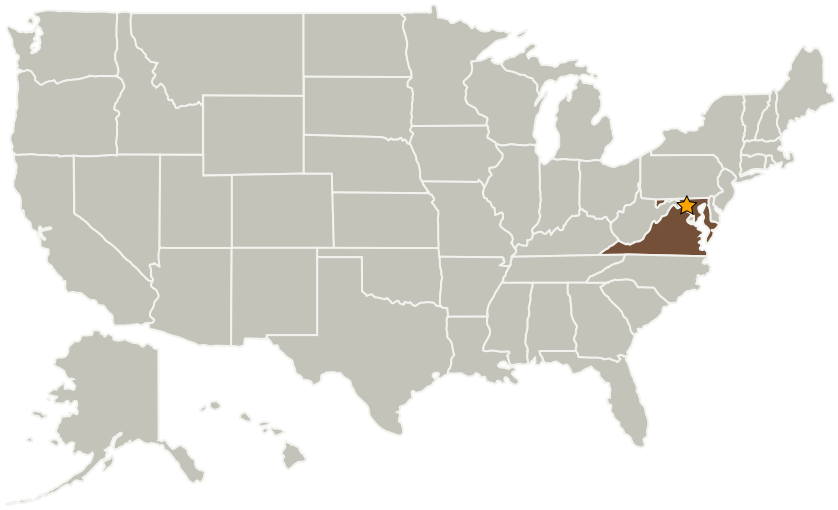
Completed Technology Project (2009 - 2009)

combatants, emergency first responders and astronauts, high altitude lighter-than-air (LTA) vehicles, deployable space habitats and structures, and deep submergence structures. Due to Metal Rubber

TM

's low modulus and high electrical conductivity, it may also be used in high performance, highly flexible and mechanically robust electronic flex circuits, flexible displays and smart electronic fabrics, and as a replacement for conventional lead-based solder.

## Primary U.S. Work Locations and Key Partners



| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| ★Goddard Space Flight Center(GSFC) | Lead Organization | NASA Center | Greenbelt, Maryland |
| Nanosonic, Inc. | Supporting Organization | Industry | Pembroke, Virginia |

| Primary U.S. Work Locations | |
|---|---|
| Maryland | Virginia |

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Center / Facility:**

Goddard Space Flight Center (GSFC)

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

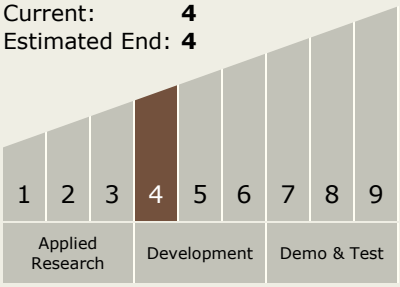
Carlos Torrez

**Principal Investigator:**

Andrea J Hill

## Technology Maturity (TRL)

Start: **4**
Current: **4**
Estimated End: **4**



# Novel Ultralow-Weight Metal Rubber Sensor System for Ultra Long-Duration Scientific Balloons, Phase I

Completed Technology Project (2009 - 2009)

## Project Transitions

**January 2009:** Project Start

**July 2009:** Closed out

**Closeout Summary:** Novel Ultralow-Weight Metal Rubber Sensor System for Ultra Long-Duration Scientific Balloons, Phase I Project Image

## Technology Areas

**Primary:**

- TX09 Entry, Descent, and Landing
  - TX09.4 Vehicle Systems
    - TX09.4.6 Instrumentation and Health Monitoring for EDL